

IB/2004/03838

# Sertifikaat

REPUBLIEK VAN SUID-AFRIKA

PATENT KANTOOR  
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EN NYWERHEID

# Certificate

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This is to certify that

the documents annexed hereto are true copies of:

Application forms P.1 and P.3, provisional specification and drawings of  
South African Patent Application No. 2003/9208 as originally filed in the  
Republic of South Africa on 26 November 2003 in the name of RAFFLE,  
Marie Thomas Gilles for an invention entitled: "CASTING OF LIGHT METAL  
ARTEFACTS".

## PRIORITY DOCUMENT

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6<sup>TH</sup>

dag van

January 2005

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PUBLIC OF SOUTH AFRICA  
PATENTS ACT, 1978  
APPLICATION FOR A PATENT AND  
KNOWLEDGEMENT OF RECEIPT  
Section 30(1) Regulation 22)

REPUBLIC OF SOUTH AFRICA  
FORM P.1 REVENUE  
(to be lodged in duplicate)  
26.11.03 R 060.00  
A&A REF: M16023-AS/MUS/Vd

THE GRANT OF A PATENT IS HEREBY REQUESTED BY THE UNDERMENTIONED APPLICANT  
ON THE BASIS OF THE PRESENT APPLICATION FILED IN DUPLICATE

1 01 PATENT APPLICATION NO. 20 03 / 9 2 0 8

1 FULL NAME(S) OF APPLICANT(S)

RAFFLE, Marie Thomas Gilles

ADDRESS(ES) OF APPLICANT(S)

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Gauteng Province, Republic of South Africa

54 TITLE OF INVENTION

" CASTING OF LIGHT METAL ARTEFACTS "

Only the items marked with an "X" in the blocks below are applicable.

☐ THE APPLICANT CLAIMS PRIORITY AS SET OUT ON THE ACCOMPANYING FORM P.2. The earliest priority claimed is

Country: No: Date:

☐ THE APPLICATION IS FOR A PATENT OF ADDITION TO PATENT APPLICATION NO. 21 01

☐ THIS APPLICATION IS A FRESH APPLICATION IN TERMS OF SECTION 37 AND BASED ON  
APPLICATION NO. 21 01

HIS APPLICATION IS ACCOMPANIED BY:

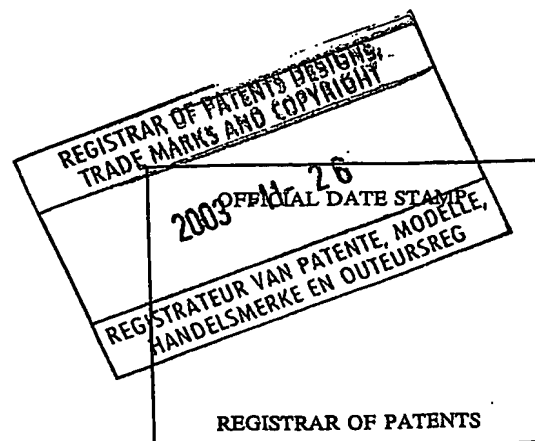
- ☒ A single copy of a provisional specification of 21 pages  
☒ Drawings of 6 sheets  
☐ Publication particulars and abstract (Form P.8 in duplicate) (for complete only)  
☐ A copy of Figure of the drawings (if any) for the abstract (for complete only)  
☐ An assignment of invention  
☐ Certified priority document(s). (State quantity)  
☐ Translation of the priority document(s)  
☐ An assignment of priority rights  
☐ A copy of Form P.2 and the specification of RSA Patent Application No. 21 01  
☒ Form P.2 in duplicate  
☒ A declaration and power of attorney on Form P.3  
☐ Request for ante-dating on Form P.4  
☐ Request for classification on Form P.9  
☐ Request for delay of acceptance on Form P.4  
☐ Extra copy of informal drawings (for complete only)

74 ADDRESS FOR SERVICE: Adams & Adams, Pretoria

Dated this 26th day of November 2003

AV vR SCHWEIZER  
ADAMS & ADAMS  
APPLICANTS PATENT ATTORNEYS

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proof of lodging but is not valid unless endorsed with official stamp



REPUBLIC OF SOUTH AFRICA  
PATENTS ACT, 1978  
DECLARATION AND POWER OF ATTORNEY  
(Section 30 - Regulation 8, 22(i)(c) and 33)

FORM P.3

PATENT APPLICATION NO

A&amp;A Ref: V16023 AS/MJS

LODGING DATE

21 01 2003/03/9208

22 26 November 2003

FULL NAME(S) OF APPLICANT(S)

71

RAFFLE, Marie Thomas Gilles

FULL NAME(S) OF INVENTOR(S)

72

RAFFLE, Marie Thomas Gilles

EARLIEST PRIORITY CLAIMED

COUNTRY

NUMBER

DATE

33

N/A

31

N/A

32

N/A

NOTE: The country must be indicated by its International Abbreviation - see schedule 4 of the Regulations

TITLE OF INVENTION

54

" CASTING OF LIGHT METAL ARTEFACTS "

\* I/We Marie Thomas Gilles RAFFLE

hereby declare that :-

1. I/we am/are the applicant(s) mentioned above;
- \*\* 2. ~~I/we have been authorized by the applicant(s) to make this declaration and have knowledge of the facts herein stated in the capacity of~~ of the applicant(s);
- \*\*\* 3. the inventor(s) of the abovementioned invention is/are the person(s) named above and the applicant(s) has/have acquired the right to apply by virtue of an assignment from the inventor(s);
4. to the best of my/our knowledge and belief, if a patent is granted on the application, there will be no lawful ground for the revocation of the patent;
- \*\*\* 5. ~~this is a convention application and the earliest application from which priority is claimed as set out above is the first application in a convention country in respect of the invention claimed in any of the claims; and~~
6. the partners and qualified staff of the firm of ADAMS & ADAMS, patent attorneys, are authorised, jointly and severally, with powers of substitution and revocation, to represent the applicant(s) in this application and to be the address for service of the applicant(s) while the application is pending and after a patent has been granted on the application.

SIGNED THIS 25th DAY OF November

2003

  
Marie Thomas Gilles RAFFLE

(no legalization necessary)

- \* In the case of application in the name of a company, partnership or firm, give full names of signatory/signatories, delete paragraph 1, and enter capacity of each signatory in paragraph 2.
- \*\* If the applicant is a natural person, delete paragraph 2.
- \*\*\* If the right to apply is not by virtue of an assignment from the inventor(s), delete "an assignment from the inventor(s)" and give details of acquisition of right.
- \*\*\*\* For non-convention applications, delete paragraph 5.

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PATENT ATTORNEYS  
PRETORIA

REPUBLIC OF SOUTH AFRICA  
Patents Act, 1978

# PROVISIONAL SPECIFICATION

(Section 30 (1) - Regulation 27)

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|----|----|-------------------------|
| 21 | 01 | OFFICIAL APPLICATION NO |
|----|----|-------------------------|

• • • 2003 / 9208

|    |              |
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| 22 | LODGING DATE |
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26 November 2003

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| 71 | FULL NAME(S) OF APPLICANT(S) |
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RAFFLE, Marie Thomas Gilles

|    |                             |
|----|-----------------------------|
| 72 | FULL NAME(S) OF INVENTOR(S) |
|----|-----------------------------|

RAFFLE, Marie Thomas Gilles

|    |                    |
|----|--------------------|
| 54 | TITLE OF INVENTION |
|----|--------------------|

" CASTING OF LIGHT METAL ARTEFACTS "

**THIS INVENTION** relates to the casting of a light metal artefact. More particularly, the invention relates to a process for casting a light metal artefact, to a casting assembly for casting light metal artefacts, to a casting apparatus or installation for casting a light metal artefact, and to a method of casting a light metal artefact using the casting apparatus or installation in accordance with the present invention. As used herein, the term light metal encompasses both light metals as such, and alloys thereof in which light metals form the major proportion.

According to a first aspect of the invention, there is provided a process for casting a light metal artefact, which process includes the steps of:

heating a die or mould for casting the artefact, to a predetermined operating temperature, the heating being by induction heating; and

charging the die or mould with molten light metal after the die or mould has reached the operating temperature.

The process may include the step of purging the die or mould, prior to the heating, so that casting of the artefact takes place under a desired atmosphere. Instead or in addition, the purging may be carried out during the heating of the die or mould. Preferably, the purging is carried out both prior to and during heating of the die or mould. The purging gas may be selected from the group consisting of argon, carbon dioxide and mixtures thereof. Instead

said purging may be by means of a gas, such as sulphur hexafluoride ( $\text{SF}_6$ ), which can act as a flux.

The process may include the step, prior to charging the die or mould with molten metal, of sealing off or locking the die or mould. In addition thereto, the process may include the step of disconnecting the supply of purging gas to the die or mould, prior to charging the die or mould with the molten metal. Typically, the supply of purging gas is discontinued when the die or mould attains its operating temperature. Charging the die or mould will typically be carried out to fill the die or mould.

The filling of the die or mould with molten metal may be carried out under pressure. In particular, and preferably, the filling of the die or mould with the molten charge is under an intermediate pressure, being neither what is known in the art as low pressure injection moulding nor what is known in the art as high pressure injection moulding. Thus, it will be appreciated that routine experimentation should be employed to determine a desired or an optimum intermediate pressure under which the die or mould should be filled with the molten charge.

The process may include the step of selecting the light metal from the group consisting of aluminium, magnesium, lithium, zinc and alloys thereof.

Preferably the light metal is selected from magnesium, aluminium and alloys thereof.

The process is expected to be useful, in particular, in the casting of light metal or alloy products selected from the group consisting of wheel rims, such as aluminium- or magnesium-alloy wheel rims, automotive gearbox casings, steering wheels, steering column housings, brake auxiliary parts or components, and automotive engine, marine and aircraft parts or components. Typically, the process will be used in the casting of aluminium- and magnesium-alloy wheel rims.

In particular, the process is expected to be useful in casting artefacts having cross-sectional thicknesses in the range 1.5 – 30mm, usually 2 – 27mm, with respective masses of 0.25 -30kg, usually 0.5 – 20kg.

Importantly, the process may include the step of providing the die or mould with a desired temperature profile, by selective application of the induction heating thereto, to promote solidification at desired rates of different parts of the molten light metal charged into the die or mould.

According to a second aspect of the invention, there is provided a casting assembly for casting a light metal artefact, which assembly includes:

a die or mould for casting the artefact; and

an induction heating arrangement comprising at least one induction coil surrounding the die or mould for heating the die or mould, prior to casting of the artefact.

The induction heating arrangement may comprise a variable frequency induction heater.

The assembly may include a gas supply connected to the die or mould for supplying purging gas to the die or mould.

The die or mould may be a disposable die, for example such as a sand casting die or mould. Instead, the die or mould may comprise a re-usable die or mould. In particular, the re-usable die or mould may be a metal die or mould, preferably a steel die or mould.

In the case of a re-usable die, the die or mould may be a multi-core or segmented die or mould, comprising two or more cores or segments. In particular, the die or mould may comprise a top core or segment to which the solidified artefact remains removably attached at the end of the casting. The top core or segment may include or be associated with release means for releasing the artefact therefrom. In this case the die or mould will typically also comprise a bottom – or face core, and a ring of side cores associated with pistons, which side cores or segments give the die or mould its segmented character. In particular, the re-usable die or mould may be

hydraulically operated, with regard to the pistons of the side cores and with regard to lifting of the top core and casting from the remaining cores to bring the casting into contact with pins forming the release means.

The die or mould will typically have a charging opening for use in filling or charging the die or mould with molten light metal. In one embodiment of the invention, the die or mould has its charging opening provided through its bottom or face core for charging or filling the die or mould from below.

The induction heating arrangement may comprise two or more induction coils, operable independently of one another in achieving a desired temperature profile in the die or mould.

The casting assembly may be of permanent construction as part of an installation, being constructed *in situ*, at a production facility for casting light metal artefacts. Instead, and preferably, the casting assembly is not of permanent construction, being moveable as part of an apparatus from one said production facility to another.

According to a third aspect of the invention, there is provided a casting apparatus or installation for casting light metal artefacts, the apparatus or installation comprising:

a casting assembly for casting a light metal artefact as defined above;

and

a melting apparatus or installation for forming a molten charge of molten light metal for use in casting the light metal artefact in the casting assembly, the melting apparatus or installation comprising a heating arrangement for heating a precursor of the molten charge.

Preferably the melting apparatus or installation is sized to melt charges of light metal which are matched in size with the size of the die or mould, so that casting of the artefact in the die or mould consumes an entire charge.

The heating arrangement of the melting apparatus or installation may be an induction heating arrangement comprising one or more heating coils. In each case where the die or mould arrangement, on the one hand, and, the melting apparatus or installation on the other hand, include one or more induction heating coils, the heating coils may be electrically connected to an electrical power supply therefor.

The melting apparatus or installation may be reciprocable relative to the casting assembly between a charging position where charging of the melting apparatus or installation with a precursor of the molten charge takes place, and a filling position where transfer of a molten charge from the melting apparatus or installation to the casting assembly takes place. Thus, the casting apparatus or installation may be

provided with rails on which wheels of a metal transfer assembly forming part of the melting apparatus or installation can run.

The invention extends to a casting facility, which includes two or more casting assemblies as defined above for casting a light metal artefact, the casting facility including the same number of melting apparatuses or installations for melting charges of light metal for charging the dies or moulds of the casting assemblies therewith, the casting assemblies sharing a common heating power supply and the melting apparatuses or installations sharing a common heating power supply, for the casting of artefacts in respective casting cycles which are sufficiently out of phase to permit such sharing.

The arrangement of the facility is particularly suitable for the case where the heating arrangement for the melting apparatuses or installations is also an induction heating arrangement, the heating power supplies being electrical power supplies.

According to a fourth aspect of the invention, there is provided a method of casting a light metal artefact, the method comprising using a casting apparatus or installation as defined above in accordance with the present invention to carry out the method steps of:

heating the die or mould for casting the artefact, to a predetermined operating temperature, the heating being by induction heating; and

charging the die or mould with molten light metal after the die or mould has reached the operating temperature, the charging taking place from the melting apparatus or installation in which the charge has been melted.

The invention will now be described, by way of a non-limiting illustrative example, with reference to the accompanying diagrammatic drawings.

In the drawings,

Figure 1 shows an exploded schematic side elevation of the various components of a casting assembly according to the invention for casting a light metal artefact in accordance with the process of the invention;

Figure 2 shows an exploded schematic side elevation of the various components of a melting apparatus or installation for use with the casting assembly, for forming a molten charge of light metal, for use in the process of the invention;

Figure 3 is a three-dimensional view of a casting apparatus or installation in accordance with the invention, for casting light metal artefacts, in accordance with the method of the invention;

Figure 4 is a three-dimensional view of a casting facility according to the invention and comprising two casting apparatuses or installations of Figure 3, for casting light metal artefacts in accordance with the method of the invention;

Figure 5 shows a series of simplified schematic side elevations of the casting apparatus or installation of Figure 3, illustrating the method of casting a light metal

artefact in the form of a magnesium alloy wheel rim, in accordance with the invention, using the casting apparatus or installation of Figure 3; and

Figure 6 is another series of simplified schematic side elevation of the casting apparatus or installation of Figure 3, further illustrating the method of casting a light metal artefact in the form of a magnesium alloy wheel rim illustrated by Figure 5.

Referring first to Figure 1 of the drawings, reference numeral 10 generally refers to a casting assembly for casting a light metal artefact, in accordance with the invention. The casting assembly 10 comprises a die or mould 12 for casting a light metal artefact in the form of a magnesium alloy wheel rim, and comprises also an induction heating arrangement 14 surrounding the die or mould 12.

The die or mould 12 is a multi-core or segmented re-useable steel die or mould, comprising a top core 16 to which a solidified artefact remains removably attached at the end of the casting process, a bottom – or face core 18 having a centrally located charging opening or passage 20 provided therethrough for charging or filling the die or mould 12 from below, and a segmented ring of four side cores 22 associated with respective pistons 24, the side cores 22 giving the die or mould 12 its segmented character. The die or mould 12 is hydraulically operated, with regard to the pistons 24 of the side cores 22 and with regard to lifting of the top core 16 and any attached light metal casting (not shown), upwardly and away from the remaining cores.

The top core 16 is associated with release means (not shown) for releasing the artefact therefrom at the end of the casting process.

The heating arrangement 14 comprises six induction coils 25, 26, 27, 28, 29 and 30, operable independently of one another, for achieving a desired temperature profile in the die or mould 12.

The casting assembly 10 also includes a purging gas supply (not shown) for supplying  $\text{SF}_6$  /  $\text{CO}_2$  purging gas to the die or mould 12 prior to and during the casting process.

Referring now to Figure 2 of the drawings, reference numeral 40 generally refers to a melting apparatus or installation for forming a molten charge of light metal, in accordance with the invention. The melting apparatus or installation 40 comprises a hollow low carbon – or mild steel cylinder or sleeve 42 of circular cross-section for holding a molten charge of light metal and also for facilitating heating of a precursor of the charge of light metal, an induction heating arrangement 44 comprising an induction coil 46 for heating contents of the cylinder or sleeve 42 to form a molten charge, and a molten metal transfer assembly 48 for transferring a molten charge of light metal from the cylinder or sleeve 42 to the die or mould 12 in which an artefact is cast.

The melting apparatus or installation 40 also includes an inert gas supply 50 for supplying argon gas to the interior of the cylinder or sleeve 42 such that melting of the light metal charge takes place under a substantially inert atmosphere, and also to provide cooling to the lower end or base of the cylinder or sleeve 42 to form a secondary seal therefor as described hereunder.

In use, the induction coil 46 is mounted on the metal transfer assembly 48, the coil 46 surrounding the cylinder or sleeve 42 to heat the contents thereof.

The transfer assembly 48 comprises a telescopically moveable multi-stage piston arrangement 52 for use in elevating the cylinder or sleeve 42 to engage lockingly with the periphery of the charging opening 20 of the die or mould 12, prior to filling the die or mould 12 with a molten charge from the cylinder or sleeve 42. The multi-stage piston arrangement 52 incorporates a central piston comprising three telescopic piston rods 54, 55, 56 with the central rod 56 having a piston head 58 provided with a conical sealing surface 59 for sealingly engaging the periphery of the opening 20 into the die or mould 12 when an entire molten charge in the cylinder or sleeve 42 has been transferred from the cylinder or sleeve 42 into the die or mould 12. The multi-stage piston arrangement 52 includes a variable force and speed controller (not shown) for controlling the rate of movement thereof and also for controlling the upward force exerted by the piston head 58 on a molten charge in the cylinder or sleeve 42 and in the die or mould 12, when

the piston head 58 sealingly engages the periphery of the charging opening 20 of the die or mould 12.

Thus, in use, the cylinder or sleeve 42 is supported on the transfer assembly 48, such that the multi-stage piston arrangement 52 is moveable within the interior of the cylinder or sleeve 42 in sliding and sufficiently sealing engagement therewith so as to enable a molten charge in the cylinder or sleeve 42 to be pushed upwardly and out of the cylinder or sleeve 42 upon the upward movement of the piston rods 54, 55, 56, to transfer and inject the molten charge into the die or mould 12.

The transfer assembly 48 also comprises a plurality of concentric barrels 60, 61, 62, 63 and 64 of different diameters. The barrels 60, 61, 62, 63 and 64 are telescopically vertically displaceable, relative to one another and nest in one another.

The barrel 60 is the bottom barrel and has wheels 66 for running on rails (not shown) forming part of the casting installation of Figures 4 - 6 for reciprocating the melting apparatus or installation 40 between a charging position where charging of the cylinder or sleeve 42 with a precursor of a molten charge takes place, and a filling position where the melting apparatus or installation 40 is in alignment with the charging opening 20 of the die or mould 12 of the casting assembly 10, to enable a molten charge formed by melting of a precursor thereof in the cylinder or sleeve 42 to be transferred therefrom into said die or mould 12, thereby typically filling it with the molten charge. The barrel 64 is the top barrel and provides a circumferentially

extending upwardly facing support ring having a groove (not shown) for sealingly engaging the lower end of the cylinder or sleeve 42 therein. The barrel 62 in turn provides a circumferentially extending upwardly facing support ring on which the induction coil 46 is supported when placed over the cylinder or sleeve 42 to surround it.

In addition to the seal provided by the groove on the barrel 64, the argon gas supplied via the gas supply 50 provides cooling to the lower end of the cylinder or sleeve 42 during melting of the precursor of the molten charge, allowing part of the molten charge formed to solidify in a zone between the piston arrangement 52 and the top barrel 64 and at the lower end of the cylinder or sleeve 42, thereby providing a secondary seal which is formed of solidified light metal from the molten charge.

Referring now to Figure 3 of the drawings, reference numeral 70 generally refers to a casting apparatus of installation for casting light metal artefacts; in accordance with the invention. The same parts are assigned the same reference numerals as in Figures 1 and 2, unless otherwise specified.

The casting apparatus or installation 70 comprises a casting assembly 10 as described above and a melting apparatus or installation 40 also as described above. The casting apparatus or installation 70 also includes a die or mould hydraulic controller 72 and a melting apparatus or installation 40 hydraulic controller 74.

The top core 16 is associated with release means (not shown) for releasing the artefact therefrom at the end of the casting process.

The casting apparatus or installation 70 also includes a central processing unit (CPU) 76 for monitoring the heating of the induction heating arrangement 14 to achieve the desired temperature profile, and also for providing feedback control to respective power supplies 92 and 94 (Figure 4) therefor.

The casting apparatus or installation 70 also includes rails (not shown) on which the wheels 66 of the metal transfer assembly 48 forming part of the melting apparatus or installation 40 can run. Thus, the melting apparatus or installation 40 is reciprocable relative to the die arrangement 12 between a charging position (as shown in Figure 3) where charging of the melting apparatus or installation 40 with a precursor of the molten charge takes place, and a filling position (see Figures 5 and 6) where transfer of a molten charge from the melting apparatus or installation 40 to the die or mould 12 of the casting assembly 10 takes place.

Referring now to Figure 4 of the drawings, reference numeral 90 generally refers to a casting facility according to the invention. The casting facility 90 comprises two casting apparatuses or installations 70, each comprising a casting assembly 10 having a die or mould 12 in which the casting of the artefact is carried out, and having a melting apparatus or installation 40 for induction melting a charge of light metal. The casting facility 90 also includes a melt induction heating power supply

92, for example of 100kW, for separately supplying power to each of the two melting apparatuses or installations 40, a die induction heating power supply 94, also for example of 100kW, for separately supplying power to each casting assembly 10, a cooling tower (not shown) for providing cooling fluid, and a gas supply control unit 96 for supplying purging gases to the casting assembly 10 and also to the melting apparatuses or installations 40.

It will be appreciated that the casting facility 90 permits two artefacts to be cast simultaneously using casting cycles which are out of phase, the melting apparatuses or installations 40 sharing the common induction heating power supply 92 and the casting facilities 10 sharing the common induction heating power supply 94. The casting of the artefacts then takes place in respective casting cycles which are sufficiently out of phase to permit such sharing. It will thus be appreciated that the casting facility 90 can be operated in quasi-continuous fashion, in that the casting apparatuses or installations 70 can be used on an alternating basis, with the one having its melting apparatus or installation 40 in its filling position and being used for casting while the other has its melting apparatus or installation 40 in its charging position and is charged with a precursor of the light metal, and being prepared to be reciprocated to its filling position, as soon as the casting process in the other casting apparatus or installation 70 is completed.

Referring now to Figures 5 and 6 of the drawings, use of the casting apparatus or installation 70 described above is illustrated with reference to casting a

light metal artefact in the form of a magnesium alloy wheel rim 100, using a precursor in the form of a pre-formed billet or ingot 102 of a magnesium-aluminium-zinc alloy known in the art as AZ91. The billet or ingot 102 is placed on the piston arrangement 52, with the associated melting apparatus or installation 40 in its charging position. The cylinder or sleeve 42 placed over the billet or ingot 102, such that the lower end of the cylinder or sleeve 42 sealingly engages said groove on the top barrel 64 of the metal transfer assembly 48. The induction coil 46 is then placed over the cylinder or sleeve 42 such that it surrounds the cylinder or sleeve 42 and is supported on the barrel 62 of the metal transfer assembly 48.

The casting assembly 10 is prepared for casting by lowering the top core 16 and raising the bottom- or face core 18 such that they engage with the ring of side core segments 22, which are placed in position using their pistons 24. Purging gas in the form of  $\text{SF}_6/\text{CO}_2$  fluxing gas mixture comprising 0.2% by volume  $\text{SF}_6$  is fed into the die or mould 12 and the die or mould 12 is heated using the induction coils 25, 26, 27, 28, 29 and 30 by electrical power fed from the induction heating power supply 94 using a pre-selected frequency, until the die or mould 12 achieves a required operating temperature, and has a desired temperature profile. The rate of heating can be altered by changing the frequency of the power supply 94, with a higher frequency resulting in a higher heating rate; and the coils 25, 26, 27, 28, 29 and 30 can be selectively operated with different power supplies thereto, to achieve said temperature profile.

The melting apparatus or installation 40 is reciprocated with the aid of the wheels 66 on the rails (not shown) on the casting apparatus or installation 70, from the charging position where charging of the cylinder or sleeve 42 with the billet or ingot 102 of a molten charge of AZ91 alloy takes place, to a filling position where the melting apparatus or installation 40 is in alignment with the charging opening 20 through the bottom- or face core 18 of the die or mould 12. The cylinder or sleeve 42 is sealingly engaged with the lower surface of the bottom- or face core 18, by raising the barrel 64 hydraulically, which also seals the cylinder or sleeve 42 to the barrel 64. The billet or ingot 102 is heated under an argon purging atmosphere introduced to the cylinder or sleeve 42 by the gas supply 50, until a molten charge of AZ91 alloy is formed, with the argon also providing cooling of the molten charge at the lower end of the cylinder or sleeve 42 to form a secondary seal in the form of a solidified portion or sprue of the light metal (not shown).

Once the desired operating temperature and temperature profile have been achieved in the die or mould 12, and the die or mould 12 has been pressure locked with the aid of the pistons 24 by means of the hydraulic controller 72, the gas supply to the cylinder or sleeve 42 is cut off and the molten charge is transferred under pressure from the cylinder or sleeve 42 into the die or mould 12 by means of the piston arrangement 52, thereby filling the die or mould 12 with the molten charge. Prior to and during injection of the molten charge into the die or mould 12, the die or mould 12 is purged with the abovementioned  $\text{SF}_6$  /  $\text{CO}_2$  fluxing gas by means of gas supply control unit 96. The piston head 58 locks sealingly against the periphery of the

charging opening 20 and partially enters the charging opening 20 to increase the pressure on the molten charge in the die or mould 12. The die or mould 12 is allowed to cool down and the melting apparatus or installation 40 is disengaged from the die or mould 12. The melting apparatus or installation 40 is then reciprocated back to its charging position.

The die or mould 12 is then opened by hydraulically disengaging the ring of side core segments 22 from one another with the aid of the pistons 24, and the top core 16 with the solidified wheel rim 100 attached thereto, is lifted, using the controller 72. The wheel rim 100 is then detached or released from the top core 16 by allowing downwardly directed pins forming part of the release means (not shown) to push the wheel rim 100 downwardly during the raising of the top core 16.

The piston arrangement 52 is lowered and then the barrels of the assembly 20 are retracted, releasing the cylinder or sleeve 42 and the solidified portion or sprue (not shown) of the molten charge which formed the secondary seal for the cylinder or sleeve 42. The used cylinder or sleeve 42 is then cleaned and repositioned back on the transfer assembly 48 in preparation for the casting of a new wheel rim 100. It will be appreciated, however, that a different cylinder or sleeve 42 may instead be used to avoid waste of production time and also to minimise the possibility of cross-contamination.

It is an advantage of the invention that the casting apparatus or installation 70 need not necessarily to be of a permanent construction, being moveable from one production facility to another with ease. Thus the casting apparatus or installation 70 may be inexpensively set up close to an end user of the artefacts to be cast, thereby reducing transportation costs, and the like.

It also a further particular advantage of the invention that the induction heating of the die or mould 12 by the heating arrangement comprising the six induction coils 25, 26, 27, 28, 29 and 30, operable independently of one another, enables a desired temperature profile to be obtained in the die or mould 12, prior to the casting step, thereby having a desirable consequential effect on the solidification rate of the various portions of the artefact, such as the wheel rim 100, thereby reducing stresses in the solidified artefact (wheel rim 100).

It is yet a further advantage of the present invention that the casting apparatus or installation 70 does not require much space for it to be erected. For example, the casting apparatus or installation 70 as described above only requires a floor space of about 20 - 30m<sup>2</sup>. The present process also offers other costs benefits such as the fact that power supply only has to be fed to the casting apparatus or installation 70 immediately prior to casting and can be switched off at the end of casting a single artefact, without adversely affecting the process. In the case of a power failure during the casting process using the method and casting apparatus or installation 70 of the present invention, it will be appreciated that, losses are confined

to the molten charge in the cylinder or sleeve 42, comprising the single billet or ingot 102, as compared to a typical foundry where the process is continuous and large amounts of metal have to be molten at any given point in time, all of which can solidify in the event of a power failure.

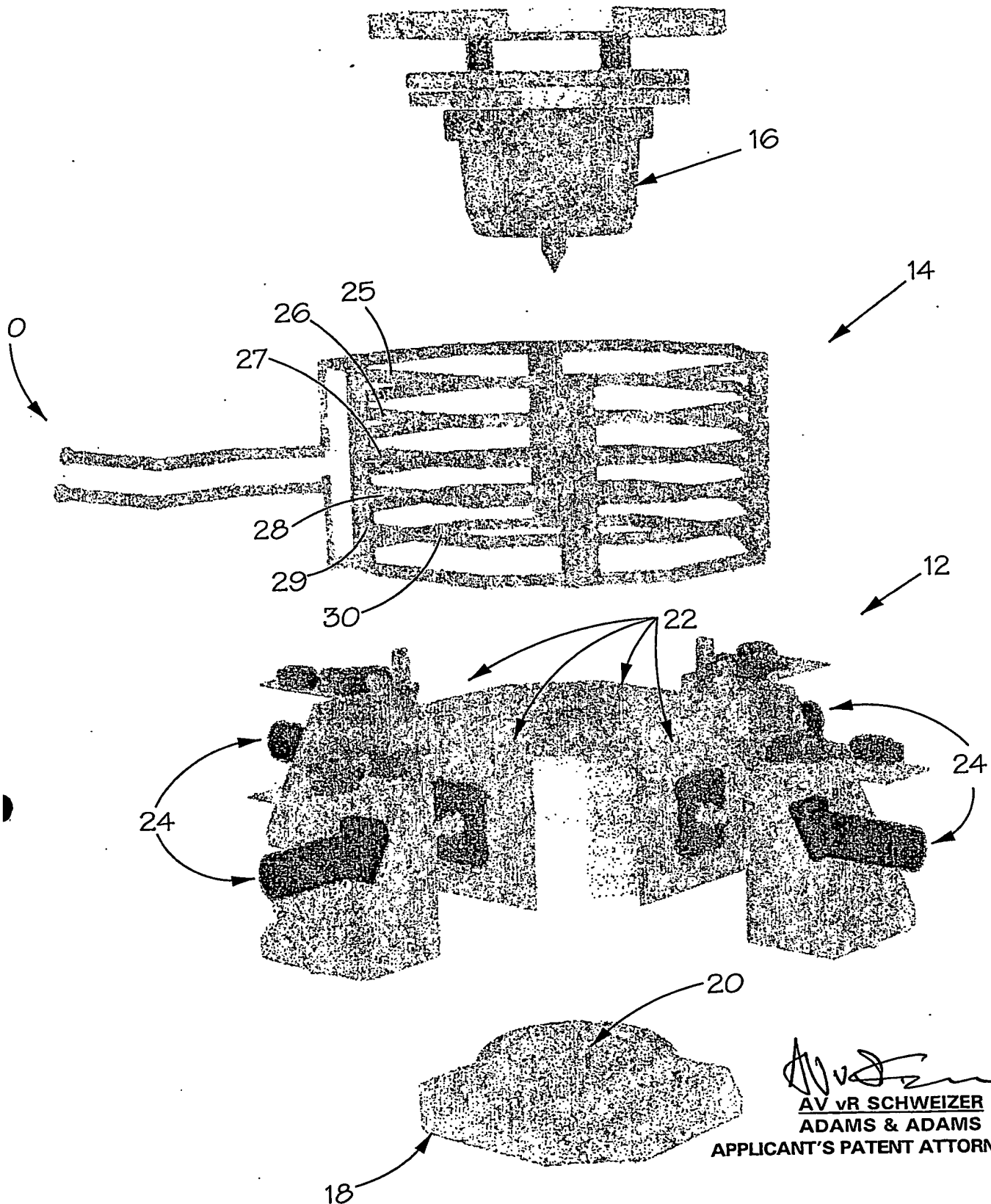
It is also still yet a further advantage of the process in accordance with the present invention, that the die or mould 12 of the casting assembly 10 does not require running-in in order to achieve the optimum process conditions. The desired casting temperature profile may be easily obtained by selectively controlling power fed to each of the coils 25, 26, 27, 28, 29 and 30. The fact that the process does not require a running-in cycle or cycles means that a particular number of billets or ingots 102, barring any power failures, should yield an equivalent number of wheel rims 100, with reduced wastage arising from reject artefacts and enhanced quality control.


Dated this 26th day of **NOVEMBER 2003**.



**AV vR SCHWEIZER**  
**ADAMS & ADAMS**

**APPLICANT'S PATENT ATTORNEY**



  
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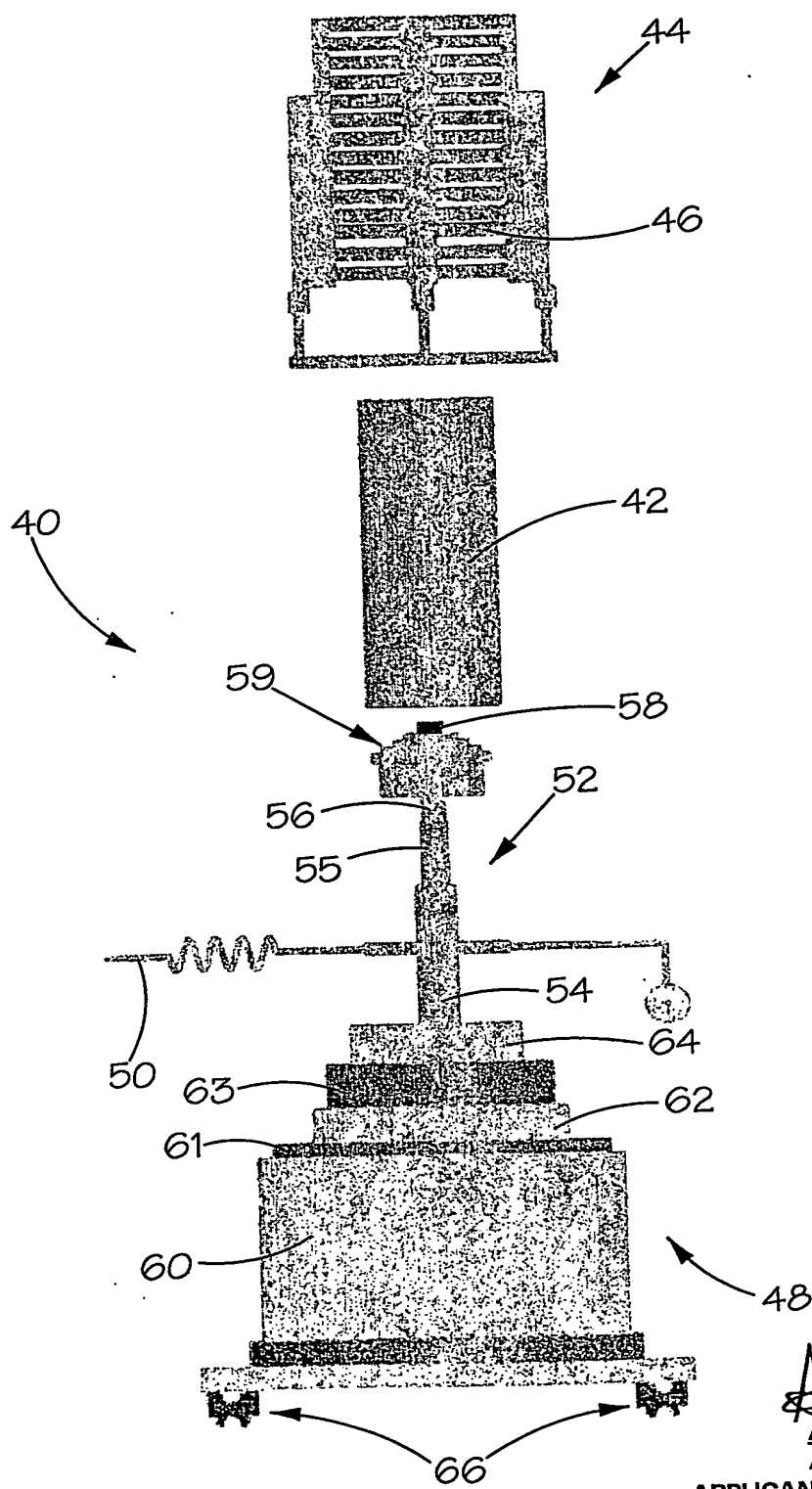

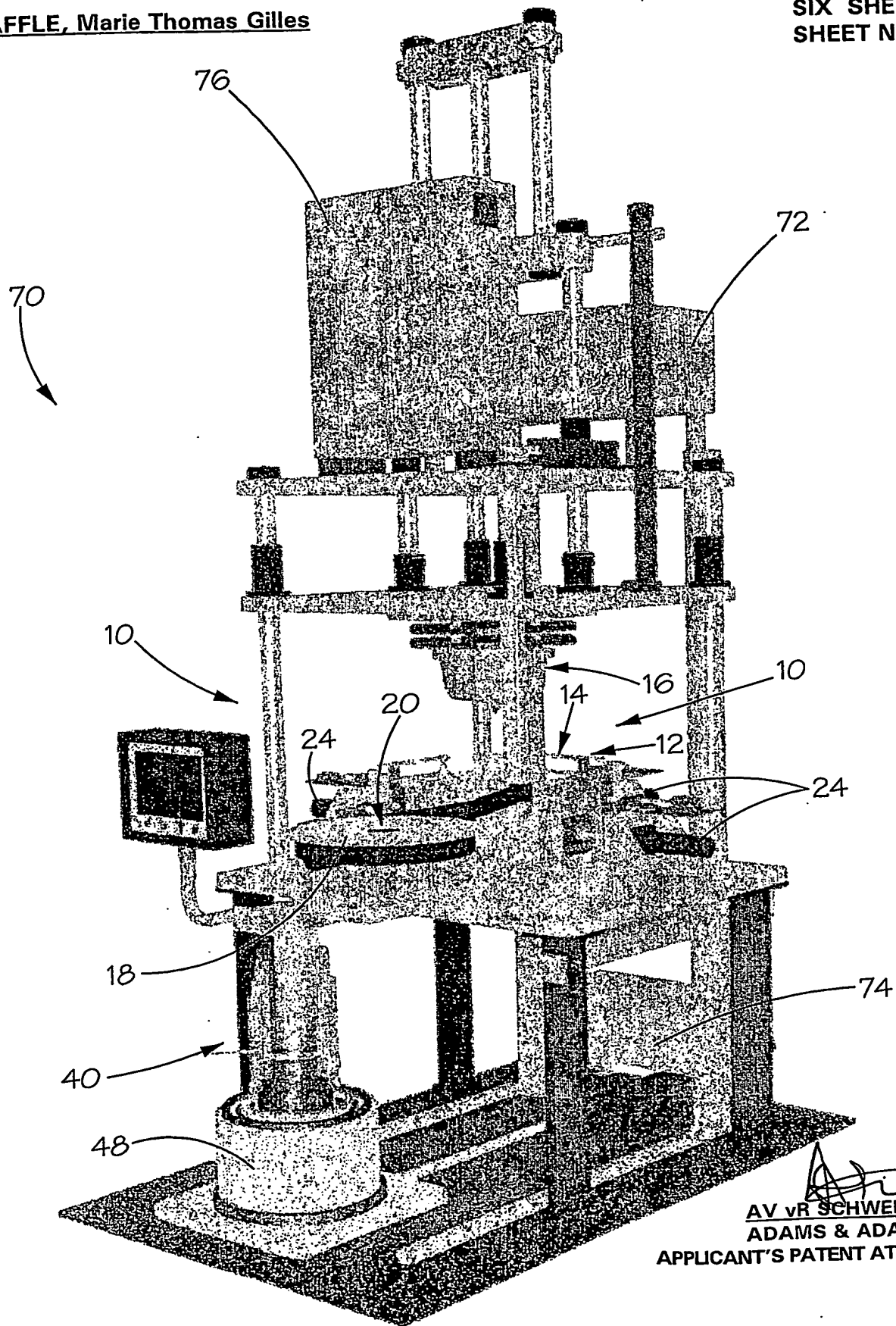


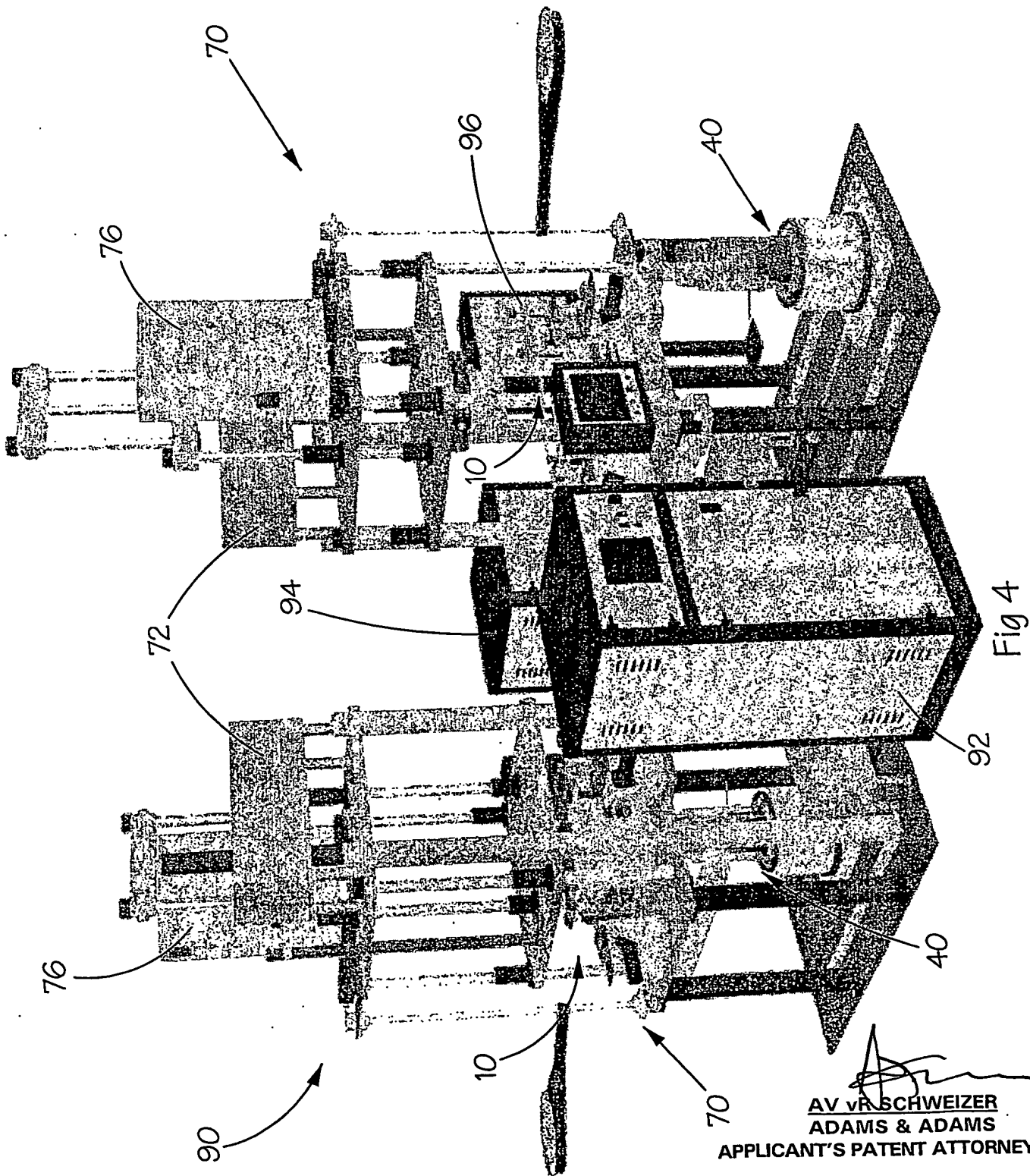
Fig 2

  
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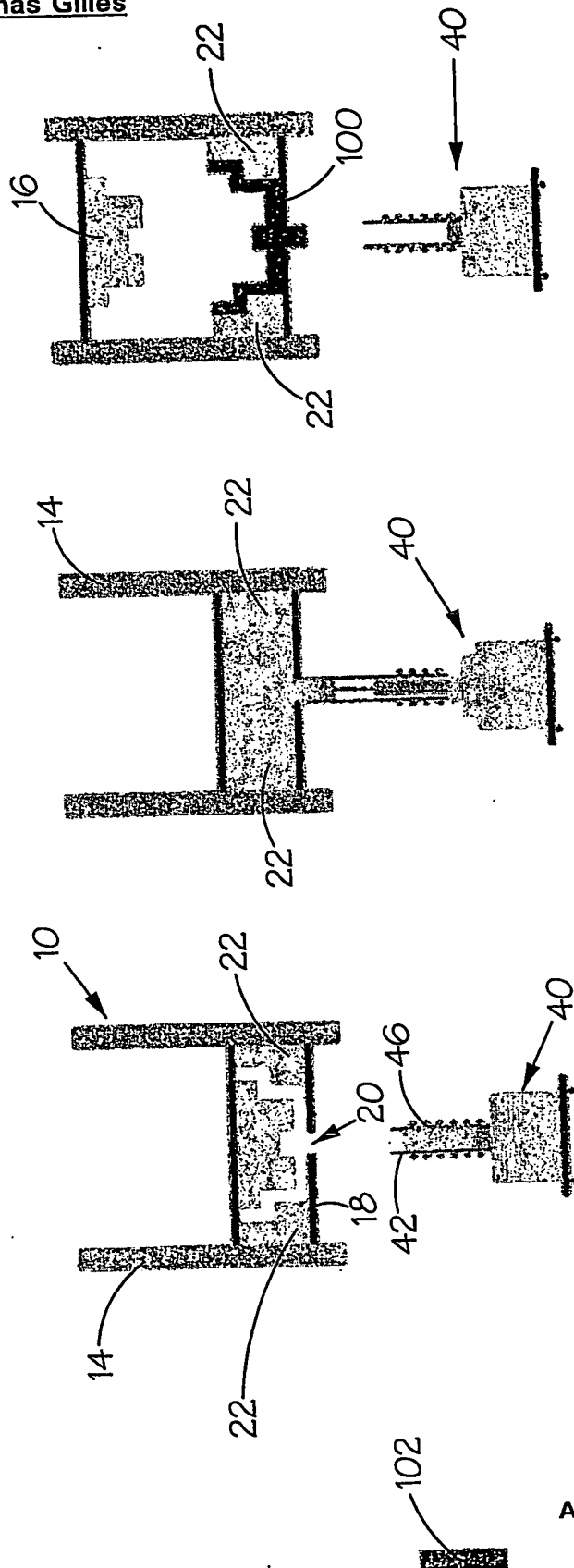



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Fig 3



*AV vR SCHWEIZER*  
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**AV vR SCHWEIZER**  
**ADAMS & ADAMS**  
**APPLICANT'S PATENT ATTORNEY**

RAFFLE, Marie Thomas Gilles

SIX SHEETS  
SHEET No. 6

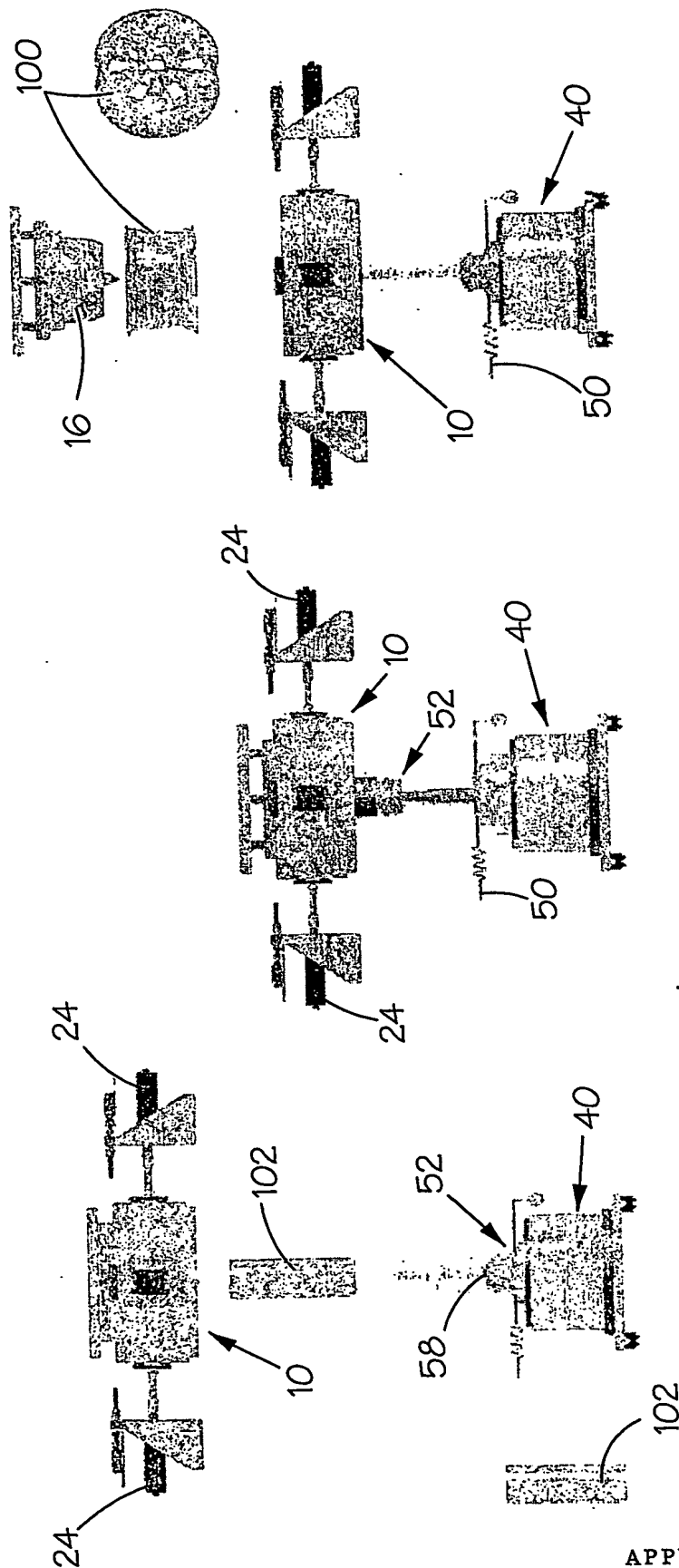


Fig 6

*[Signature]*  
AV vR SCHWEIZER  
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